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ABSTRACT

The field of biotechnology, and specifically recombinant DNA technology, is transforming the way that many feel about the nature and purposes of biology. This newsletter annual supplement contains several articles addressing the topic of biotechnology and the importance that the topic should be given in science classes. James D. Watson's article, "Biotechnology: The Charge to Education," calling for teachers to foster DNA literacy in their classrooms, is the keynote of this document. Also included are: (1) "Searching for DNA Literacy" (Jeff Diamond); (2) "Biotechnology: A 'Scientific' Term in Name Only" (Henry I. Miller and Frank E. Young); (3) "The Science of Liposome-Based Pharmaceuticals"; (4) a list of 18 biotechnology related organizations; (5) a bibliography of 31 sources on biotechnology; (6) a list of 68 related journal articles; (7) a list of 12 related audiovisual materials; and (8) a review of a biotechnology instructional materials package called "Biostar." (CW)

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BIOTECHNOLOGY

Teachers Clearinghouse for Science and Society Education

Newsletter, Supplement 1987

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Nancy S. Van Vranken, Supplement Editor

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TEACHERS CLEARINGHOUSE
FOR SCIENCE AND SOCIETY EDUCATION
NEWSLETTER

Supplement 1987

BIOTECHNOLOGY

THE CHARGE TO EDUCATION

by
James D. Watson
Director
Cold Spring Harbor Laboratory

Recombinant DNA now dominates biological research to an extent that not even the most enthusiastic protagonist would have guessed only five years ago. Particularly important has been the role of recombinant DNA in establishing the highly plastic nature of the eukaryotic genome, with its split, movable, and rearranging genes. The proposed world-wide effort to work out the entire sequence of the human genome has far-reaching implication for the diagnosis and treatment of genetic diseases.

Already, genetically engineered organisms are functioning as economically viable factories to produce pharmaceuticals. Equally significant are the transgenic animals that will soon transform animal husbandry, as well as provide important insights about differential gene expression during development. Molecular engineers of the chemical industry are now busy trying to build super-enzymes which mimic the elegant efficiency of biological catalysts.

Biology has truly stepped into a new era. As a result, no science educator can afford not to be conversant with the procedures and implications of recombinant DNA. Upon our shoulders rests the critical task of fostering "DNA literacy" and of counteracting the twisted rhetoric of vocal detractors of scientific progress.

Before us lies the business of revitalizing the science teaching profession, retooling antiquated science classrooms, and creating an educational infrastructure to spark widespread awareness of the DNA revolution. It is a huge task, but the stakes of biotechnical illiteracy are too high.

* * * *

Dr. Watson helped launch the biological revolution when, in 1953, he and his collaborator Francis Crick determined the structure of the DNA molecule. For this effort, he shared the 1963 Nobel Prize. He is the author of several books, including the widely-used textbook, Molecular Biology of the Gene, and the popular best seller, The Double Helix.

FROM THE EDITOR

There are several people who deserve special thanks for their help in putting this supplement together. First and perhaps foremost, is Dave Micklos of the Cold Spring Harbor Laboratory. As I am fortunate enough to have this institution as a next-door neighbor in Long Island, step one in my research was to call and make an appointment with Dave. When the hour arrived, I was merrily mowing my lawn-- but with a gnawing feeling that I was meant to be doing something else. I was. Upon remembering , I leapt into my car (in my lawn-mowing outfit) and flew to the lab, only to realize that I had forgotten his name. He was therefore confronted with a frazzled soul strangely resembling a "bag lady," seemingly insane, muttering something about an organization he had never heard of. Hardly the picture of a professional researcher. Instead of throwing me out of his office, he kept his aplomb and gave me some names--a bit warily to be sure__ and started the research rolling.

One of the names was Dave Smith of the Biotechnology Center of the University of North Carolina. He was willing to spend hours on the telephone giving me leads of one sort or another. He was a great source of both information and moral support.

Jeff Brown of Biostar Corporation was another person willing to spend an inordinant amount of time on this project. Not only did he send all the materials his company publishes, but he provided a great number of contacts.

Sara Anderson, an old friend, also deserves a great many thanks. Her bibliography arrived at a low point when it looked as if there weren't many materials available.

Dorothy Walter's bibliography arrived just as this publication was going to the printer, but it provided the icing on the cake. It is a wonderful resource and she too deserves many thanks.

A special note of appreciation has to go to James D. Watson both for his article and his willingness to support the efforts of the Clearinghouse. His commitment to education is profound and is heartening to all those in the field. Without his help and the help of all those who contributed time and materials, this publication would not exist.

THE TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC., is a not-for-profit organization founded at the New Lincoln School on 11 March, 1982 by Irma S. Jarcho, John L. Roeder, and Nancy S. Van Vranken. Its purpose is to channel information on science and society courses as well as data on available materials and other resources. The organization maintains files, open by appointment to all interested teachers, at The New Lincoln School (210 East 77th St., New York, Ny 10021) and publishes a Newsletter three times a year. Each year it also publishes a supplement dedicated to a single topic of current interest. These services are offered free of charge to all those who inquire. Funding for The Clearinghouse comes from individual donations and grants from the Weezie Foundation and the Sanford C. Bernstein foundation.

Supplement Editor: Nancy S. Van Vranken

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John L. Roeder

SEARCHING FOR DNA LITERACY

by

Jeff Diamond
Cold Spring Harbor Laboratory

Fred Sculco looks at the photograph again and scratches his head. The Poloroid print, showing pieces of DNA that were cut by several different enzymes, has him puzzled. The bright bands on the picture, signifying portions of the genetic code, appear simple compared to a heiroglyphical Boston street map or a lacrosse field diagram, with both of which Sculco is very familiar. Still, the 42-year-old Massachusetts biology teacher and lacrosse coach is mystified. Unlike the majority of the nation, to which biotechnology remains a mystery, Sculco will find answers to his questions. He is one of 25 science teachers from the Boston area and more than 250 nationwide who participated this summer in the Vector DNA Science Workshops, sponsored by Cold Spring Harbor Laboratory.

By the end of the intense week Sculco had learned to cut and join pieces of DNA and then insert the recombined DNA into bacterial cells. The cells exhibited new growth properties due to their new genetic identity.

This rare opportunity for high school educators to learn bio- technolgy firsthand is the centerpiece of the Laboratory's DNA Literacy program. In 1985, Program Director David Micklos teamed with former postdoctoral fellow Greg Freyer, now at the Memorial Sloan-Kettering Cancer Center in New York City, to write DNA Science: A First Laboratory Course in Recombinant DNA Technology. A combination of laboratory procedures and narrative chapters, DNA Science serves as a text for the workshop.

Mr. Micklos and Dr. Freyer tinkered with procedures used by practicing scientists, adjusting the length of reactions and concentrations of reagents, so that novices could achieve optimum results. The protocols were first tested in 1985 by Long Island

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BIOTECHNOLOGY: A "SCIENTIFIC" TERM IN NAME ONLY

by

Dr.Henry I. Miller
And Dr.Frank E. Young

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Defining the terms "biotechnology" and "genetic engineering" isn't an easy task, since the terms don't represent natural groupings of processes or products. They connote something different to individual commentators, journalists, organizations, congressional staffers and members of the public. The terms are ambiguous, the source of much confusion and little advantage, and we would do well to return to more specific and descriptive terms. Laymen would understand them better and the complaints of poorly informed critics would be put into perspective.

The term " biotechnology," which seems to have originated in the 1970s, is defined in numerous ways. One of the broader definitions-- the application of biological systems and organisms to technical and industrial processes-- was coined by a White House working group on biotechnology several years ago and clearly encompasses both old and new processes and products. These include processes as different as fish farming, the production of enzymes for laundry detergents and the genetic manipulation of bacteria to clean up oil spills or to produce insulin. The press, on the other hand, often uses "biotechnolgy" to mean only its newest, state- of-the-art manifestations. "Genetic engineering" is at least as much abused.

These usages often are disingenuous. Neither biotechnology nor genetic engineering is a new concept. A primitive form of biotechnology dates back at least to 6000 B.C. when the Babylonians used microorganisms in fermentation to brew alcoholic beverages. And genetic engineering

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teachers and students. Since that time experiments have been continuously improved; the overall success rate of experiments hovers at 80 percent. Dr. Freyer has even gone to the extent of developing two new DNA molecules that are designed for teaching principals of recombinant DNA.

In the summer of 1986, a custom van, dubbed the Vector DNA Mobile Laboratory, was purchased through a grant from Citicorp/Citibank. The van carried equipment and three crew members to seven high schools and colleges from Boston Massachusetts to Davis California. Tremendous response to the program expanded the course total to 14 in 1987, creating the need for a second van and for a full-time senior staff member. Dr. Mark Bloom, a molecular biologist from Michigan State University, joined the program in June, 1987 as education manager.

Each course requires months of planning and coordination between Literacy Program staff and a local organizer. "There were so many people involved," said Linda Bayne, who organized a course at Butler University in Indianapolis "but it was worth the effort."

With advance preparations complete, the Vector Crew arrives in the host town on Sunday night. The following morning, as parti cipants are introduced to the history of molecular biology by the senior instructor , lab assistants transform a standard lab classroom into a DNA lab, complete with centrifuges, water baths, electrophoresis apparatus and photographic equipment.

Core grants received this summer from the National Science Foundation and the Josiah Macy, Jr. Foundation, totalling $900,000 through 1990, now allow breathing room to plan for future growth. In addition to funding nine workshops per year and providing salary support for members of the DNA Literacy staff, these grants also make possible a coordinated follow-up and evaluation program.

The evaluation program is being coordinated by John Kruper, a Ph.D. student at the University of Illinois at Chicago, who will base his doctoral dissertation on statistics gathered from repeated surveys of workshop participants. In addition to Mr. Kruper, three other interns played key roles as lab managers during the 1987 summer tour; Jeff Mondschein, a freshman at New York University who completed his second summer with the Vector program; Jeff Diamond, a junior at Duke University; and Tom Hyland, a freshman at Renssalaer Polytechnic Institute.

A week of intensive nine-hour days leaves participants catching their breath and addressing special problems for the first time since college. "I hadn't realized in a long time how frustrating it is when everyone else gets a certain result, and you're standing there with unexpected results," said Phyllis Sonnenschein, who loaded too much DNA in her first gel, resulting in a blurred photograph.

Sonnenschein saw the silver lining in her cloudy results. "If everything goes right, there's a certain amount you can learn from a lab," she said, "but I think if something goes wrong there's even more you can learn about the mechanism of what's happening."

The lab work, about five hours per day, is the focal point of the course. In addition, morning lectures cover topics ranging from the history of DNA science to the molecular basis of development to current research on cancer genes. The afternoons are filled with lively discussions on troubleshooting, the risks and benefits of bio- technolgy, and the practical aspects of setting up a classroom lab. Twice during the workshop, geneticists, sometimes prominent researchers such as Nobel Laureate David Baltimore, provide valuable insight into the practical applications of genetic engineering in the research laboratory.

The new perspective seems to instill an an ambitious attitude, as teachers become determined to go beyond the workshop to learn more about DNA. "This course is like a primer for me," Ms.

Sonnenschein said, "and it now gives me the basis for learning more myself. You can't teach kids something if you don't understand it , and before I came to this course, I didn't under- stand anything."

Gradually,the mystique that cloaks biotechnolgy disappears. Genetic engineering becomes understandable and, therefore, teachable. "I Think what you've got here is really not magic," Mr. Sculco said. "It's very comprehensible.

In the first several lab sessions participants are introduced to the micropipet, an implement that can accurate measure one millionth of a liter and that soon becomes an extension of their own hands. The rest of the week is spent learning to cut and n manipulate DNA, determining the genetic fingerprint of small chromosomes, joining DNA fragments to form hybrid chromosomes, and finally, artificially inserting these recombinant DNA molecules into living cells. Growth of the cells on antibiotics to which they were previously susceptible gives visible proof that the recombinant molecule has confered new life properties.

Friday is the dramatic climax of the week. DNA is extracted from bacteria showing the newly- acquired antibiotic resistance. A genetic fingerprint provides molecular confirmation that a recombinant molecule is, indeed, the cause of the bacteria's altered genetic identity.

After a week of pipetting, centrifuging and sterilizing, Fred Sculco smiles triumphantly at photographic proof of his own recombinant molecule. The week has been an education in bio- technology, in teaching and in learning. "Its always great to get to the other side of the lectern and be a student instead of a teacher," Sculco said. "Its been a very fulfilling experience to be with people who love to teach and who are interest in being good at it. That's why we are here."

Though the DNA Workshop continues to draw enthusiastic reponses from its participants, the number of workshops will decrease to about nine in 1988. By then, The Literacy Program will have made itself a permanent home at 495 Main Street in Cold Spring Harbor Village, only two miles from the main Laboratory campus.

The new institution, which is scheduled to formally open in January 1988 will be called the DNA Learning Center. In a more permanent setting, Dr. Mark Bloom, newly-appointed educational manager of the Center, hopes to recreate the experiments already performed in the Vector program and develop new protocols, to meet a growing demand from participants for new experiments.

According to Project Director David Micklos, the Center will serve as an "explorotorium of DNA", centering peoples' attention on the DNA molecule and its ultimate role in influencing the life and health of each living thing. Initial renovations to the former schoolhouse, which is being leased from the Cold Spring Harbor Central School District, will create a modern teaching laboratory where students, teachers, and casual visitors can gain hands-on experience with DNA. "The teaching laboratory will be the heart of the institution," said Mr. Micklos. "We want people to learn about science in the same way that scientists do -- by asking questions and performing experiments."

The first phase of renovations, costing approximately $160,000, will also include an auditorium for video presentations and public lectures, offices for the Learning Center Staff, and an exhibit area. The first exhibit, "100 Years of Science at Cold Spring Harbor," will commemorate the Laboratory's centennial birthday in 1990 and will contain previously unseen memorabilia gleened from the Laboratory's archives. One of the largest off-campus projects the Laboratory has ever undertaken, complete development costs of the Learning Center-- which include additional exhibits and eventual purchase of the building-- may run $4 million.

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should be dated from man's recognition that animals and crop plants can be selected to enhance desired characteristics.

During the past half-century, better understanding of genetics at the molecular level has added to the sophistication of the genetic manipulation of the microorganisms. An excellent example is the genetic improvement of the mold that produces penicillin: During the past several decades, penicillin yields have been increased more than a hundredfold. Similarly agricultural crops have been genetically improved with astonishing success. The genetic engineering of corn plants for human consumption was recognized in 1970 with the Nobel Prize. These are "genetic engineering" successes of monumental proportions. The newest biotechnological techniques, called recombinant DNA, or "gene-splicing," provide still more precise, better understood, and more predictable methods for manipulating genetic material in useful ways.

It shouldn't be surprising that confusion about scientific technology is endemic among the public and the press, when governments and even scientists suffer from the same malady. Several recent examples are instructive.

In 1985, a bill was introduced in Congress that defined a "genetically engineered" microorginism for purposes--of regulation in an extraordinary way-- as "bacterium, virus, fungus, blue-green alga, or protist, the genetic material of which has been deliberately altered by human intervention." This defininition, seemingly plucked from the ether, encompasses innumerable current production organisms of economic importance that are innocuous by any criteria (including those used to manufacture new biotechnology products such as human insulin, growth hormone, interferons, and hepatitis B vaccine, as well as traditional biotechnolgy products such as penicillin, tetracycline, live viral vaccines, etc.). At the same time, the definition would omit organisms well known to be harmful to man, animals or plants. This demonstrates the folly of using an ambiguous term -- especially when it is defined arbitrarily and carelessly.

Another example of confusion and lack of precision surrounding "biotechnolgy" occurred during the deliberations of the Organization for Economic Cooperation and Development (OECD) Working Group on Biotechnology. These efforts yielded a widely praised document on recombinant DNA safety considerations. However, a second major part of the project-- a description of governmental regulation of "biotechnology" in OECD member countries-- had to be abandoned.

The information for this project was to have been obtained by a questionnaire sent to appropriate agencies within the various countries. It defined genetic engineering broadly, and, it was hoped, clearly and prominently: "Genetic engineering is considered broadly and can include the manipulation of genetic material by (1) recombinant DNA techniques; (2) other techniques such as mutation, hybridoma, conjugation, transduction, etc.; and (3) more traditional techniques, such as selective breeding." However the returns showed that different countries had used widely disparate definitions to frame their responses. Some considered only recombinant DNA processes and products; others used the broad definition as requested; still other employed an intermediate interpretation.

The anecdotes described here are not isolated incidents, and there is accumulating disenchantment with the rubic "biotechnology." A recent General Accounting Office report on biotechnology concluded: "Because of the inconsistent interpretation of the term 'biotechnology'... it may be useful for the purpose of discussing possible regulatory approaches, to avoid the term 'biotechnology' and instead use more specific terms...." David Kingsbury, assistant director of the

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National Science Foundation, made the same point during a recent conference sponsored by the Office of Technology Assessment that addressed research funding for "biotechnology."

The GAO and Mr. Kingsbury are correct. There is a need for more precise communication in science and technology generally, and specifically for cleaning up the " biotechnology' and "genetic engineering" argot. Reference to the appropriate constituents or subsets of these catchalls would be more informative, lucid and useful. Biochemistry, microbiology, ecology, recombinant DNA, live vaccines, therapeutic monoclonal antibodies, enzymes..... By using terms such as these, we would convey our meaning more clearly, whether the intent is to laud progress, or to call for oversight, or to seek additional funding. Is that degree of verbal and literary discipline too much to ask?

SEARCHING FOR DNA LITERACY (continued)

Dr. Bloom hopes to create a place where the science and non-science world can meet. This mission will be shared by full-time staff that will soon include and education coordinator and administrative assistant. However, like a more traditional museum, the DNA Learning Center will rely heavily on volunteer help from local teachers, students, and interested nonscientists.

The Center's close proximity to the Laboratory will provide a unique forum for public discussion of the personal, social and ethical implications of DNA technolgy. "DNA science will have an increasing impact on people's lives," said Dr. Bloom. "The public needs to view recombinant DNA as an extension of traditional genetics, which gave us both poodles and pit bulls. It should be neither feared nor trusted blindly."

For more information about this program, contact:
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Cold Spring Harbor Laboratory
Bungtown Road
Cold Spring Harbor, NY 11724
(516) 367-8397

THE SCIENCE OF LIPOSOME-BASED PHARMACEUTICALS

Minimizing a drug's risk:benefit ratio has always been one of the major goals of both clinical and pharmaceutical research. A theoretical route to that goal is to target delivery of the drug in question to the dieased tissue and to no other, thus minimizing the amount of the drug needed as well as its systemic side effects. That route is rapidly achieving practicality through the use of liposomes-- tiny (about 100,000 to the linear inch) spheres made up of many layers of phospholipids, the nontoxic fatty molecules that constitute the membranes of all the body's cells. Active ingredients are carried between the layers of lipid if water soluable, or within the layers themselves if fat soluable, the combination constituting a new catagory of pharmaceutical.

It has been over a quarter century since an English physiologist studying blood clotting accidentally discovered that when he added water to a flask in which he had dried phospholipid to a film, it formed microscopic bubbles of lipid with water trapped inside. Those bubbles were immediately put to use by scientists who rapidly discovered that liposomes can react with intact cells in a variety of ways.

Liposomes can adhere (or absorb) to the surface lipid bylayer of almost any type of cell. In the simplest interaction the absorbed liposome slowly releases its cargo, and if the drug it is carrying normally would enter that particular type of cell, it does so; if not, it stays in the extracellular fluid.

Under certain circumstances, adsorbed liposomes can exchange lipids with the cell membrane. Such liposomal lipids might either remain in the cell membrane or be redistributed to intracellular membranes (any drug bound to an exchanged lipid might move into the cell along with it). Alternatively, the lipsosome may fuse with the cell membrane and directly release its contents into the cell.

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A fourth interaction occurs primarily with one class of cell-- the phagocytes, cells of the body's immune system that engulf and destroy foreign particles, including bacteria and viruses. In fact, that very mechanism was responsible for the failure of many early attempts to enhance drug delivery using liposomes; the immune system destroyed the liposomes and their cargo before they could reach their targets. Undaunted, researchers proceeded to utilize that drawback. They began studying ways to use liposomes that were loaded with agents known to be effective against infections of the reticuloendo- thelial system: macrophages and other phagocytes in the lymph nodes, liver, spleen, bone marrow, lungs, blood and lymph.

One such infection is leishmaniasis, a parasitic disease that is rapidly fatal when it attacks the patient's liver and spleen. Tragically, the only effective drugs-- which contain the metal antimony, a chemical relative of arsenic-- are also often lethal; patients who do not die of the infection often die of the drug-induced heart, liver or kidney failure. Investigators at the Walter Reed Army Institute of Research and the Zoological Society of London independently tried treating leishmaniasis in animals with antimonal drugs entrapped in liposome. Not only did the drugs control the infection, the effective dose of free drug injected into the peritoneal cavity of infected hamsters was 700 times larger than the effective dose of liposomal drug injected by the same route.

Small doses of liposomal antibiotics have similarly been effective in animals with bacterial infections--namely streptomycin for brucellosis in guinea pigs, penicillin for listeriosis in mice, and gentamicin for salmonellosis in mice.

The antibiotic work in intracellular infections has been analogous to a "trojan horse" delivery system, in which the liposome acts as a carrier that delivers the drug rapidly and efficiently to the site where it is needed. but not all effective liposomal drugs act in the same way. An example is the widely used but highly toxic cancer agent doxorubicin, which attacks rapidly dividing cells and kills them. It also, however, destroys cells in the heart, hair follicles, intestine, and immune system. The baldness, vomiting and immune suppression are reversible, the progressive heart failure is not.

Recent animal trials have shown that encapsulated doxorubicin is not only effective at lower doses but measurably less cardiotoxic. The mechanism is not clear, by macrophages probably have little, if anything to do with it; cancer cells are notorious for hiding from immune surveillance, and indeed that is the essence of why they are so lethal.

Systemic fungal infections are common and can be devastating in patients whose immune systems are compromised by disease or drugs (such as in most forms of cancer chemotherapy and transplants). Yet, under a "compassionate investigational protocol" liposomal amphrtericin B has in the past months been remarkably effective in at least half of more than twenty patients who had lifethreatening systemic fungal infections against which all knoen agents had failed. Again, the mechanism by which the liposomal agent is so effective remains elusive, but phagocytic focussing is not a likely candidate, since many of these patients are immunosuppressed to begin with.

Liposomes today are being used in vaccine research not only to carry antigens to the celss that recognize them and thus initiate an immune response but also to themselves participate in the immune response by enhancing cellular immunity.

Thus, it is becoming clear that the search for new drug delivery systems is not only beginning to produce the desired result but to reveal the potential for new uses for new indications with improved clinical efficacy.

Thank you to the public relations department of the Liposome Company for allowing us to use this article in its entirety.

ORGANIZATIONS

American Institute of Biological Science
730 11th Street, N.W.
Washington, DC 20001
202-628-1500
Publishes: "BioScience" (monthly) and "Forum" (bi-monthly)

American Society for Cell Biology
9650 Rockville Pike
Bethesda, MD 20814
301-530-7153
Publishes:"Journal of Cell Biology" (monthly), a newsletter (quarterly) and "Methods in Cell Biology" (2-3/yr.)

American Society of Human Genetics
15501-B Monona Drive
Derwood, MD 20855
301-424-4120
Publishes: "American Journal of Human Genetics" (bi monthly); "Careers in Human Genetics" (pamphlet) and "Guide to Human Genetics Training Programs in North America."

Center for Bioethics
Clinical Research Inst. of Montreal
110 Pine Ave. West
Montreal PQ Canada H2W 1R7
Publishes Proceedings and monographs

Center for Human Genetics
Firehouse Hill
Bar Harbor, ME 04609
207-288-5815
Publishes a newsletter 3 times a year.

Committee for Responsible Genetics
186-A South Street
Boston, MA 02111
617-423-0650
Publishes "Gene Watch" (quarterly)

University of Colorado Health Sciences Center Genetics Unit
4200 East 9th Ave.
Denver, CO 80262

Publishes "Genetics: A Human Approach." Offers teaching guides, supplementary materials and slide sets.

Industrial Biotechnology Association
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National Council on Gene Resources
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Conducts regular seminars, conferences and educational programs

Agricultural Research Service NE
Regional Information Office
U.S.D.A., Beltsville
AgriculturalResearch Center-West
Building 003, Room 251
Beltsville, MD 20705

Science and Technology Division,
Library of Congress Science Reference Section
10 First Street, S.E.
Washington, DC 20540

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World Biological Society
3615 Carson Drive
Amarillo, Texas 79109
806-355-9369

BIBLIOGRAPHY OF SOURCES OF INFORMATION ABOUT BIOTECHNOLOGY

Compiled and annotated
by Sara F. Anderson

Biotechnology, the use of living organisms to make commercial products, is a fast-growing part of the U.S. economy. It is hailed as a means for obtaining substances which are valuable, particularly for medical uses, and which can be made in much larger quantities and less expensively than was previously possible. Using recombinant DNA techniques hormones such as human growth hormone and insulin can be made available to more patients at a lower cost. Monoclonal antibody technology is used to produce large amounts of pure antibodies which can be used in fighting viral diseases which currently resist our efforts to either prevent or cure them.

However, the use of biotechnology raises some serious social, legal, and ethical problems. For instance, some parents seek human growth hormone for their normal, but short children because they want them to have the advantage of larger size in sports. (McDonald, 1986) In the field of agriculture, recombinant DNA and plant tissue culture techniques make possible the development and propagation of new varieties, many of which are of great economic vlaue. However, in developing varieties with some economically desirable trait, some other traits such as resistance to disease, may be lost. (Doyle, 1985)

Additional questions about the use of biotechnologies involve ensuring that microbes altered by recombinant DNA technolgy do not escape the laboratory and cause illness, and that the effects on ourselves as well as those on the natural world not be harmful if humans assume a great deal of control over evolution. (see especially Rifkin, 1983)

Below is a bibliography of sources of information on biotechnolgy itself, and about the history of the development of the techniques as well as articles and books which raise the social and ethical issues involved.

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OTHER AUDIO-VISUALS
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4 filmstrips with cassettes (#635) from Prentice Hall Media. Available from Carolina Biological Supply.
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OTHER CURRICULAR RESOURCES

Maxine Widemeyer at Oakwood Collegiate in Toronto spent a sabbatical working under Dr. Ron Pearlman at York University, developing protocols for bacterial transformation. These will be introduced into the curriculum at Oakwood Collegiate beginning in January. To contact her, write to the school at: 991 St. Clair West Toronto, M6E1A3 (416) 393-1780.

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COMMENTARY

by
John L. Roeder
Teachers Clearinghouse
Newsletter Editor

Two Supplements ago I wrote about the PCBs (PolyChlorinated Biphenyls) polluting the Hudson River, largely from the General Electric Plant. Last year's supplement discussed all varieties of toxic waste. It is curious that biotechnology, the topic of this year's Supplement, may furnish an answer to these problems. The key is the discovery of microorganisms which are able to degrade such chlorinated hydrocarbons as PCB, TCE (TriChloroethylEne) and TCA (TriChloroethAne). The catch is that these microorganisms must be "fed" in order to "do their thing." -- and the amounts of methanol acetate or methane needed for "food" can be 100 to 1000 times as great as the amount of toxin degraded. Now, perhaps, genetic engineering can improve the efficiency of these micro- organisms. Meanwhile General Electric is proceeding with work on nature's own Pseudomonas putida LB 400. They degraded 50 percent of the PCBs in soil at ambient temperatures in 100 days.

Suggested Reading: Leslie Roberts "Discovering Microbes With A Taste for PCBs," Science, 237 975-977 (28 May, 87)

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EDITOR'S NOTE

This supplement is intended to introduce teachers to the field of biotechnology. It is just a sampling of the literature and materials available. There is a great deal more out there. Many teachers are now developing their own materials and bibliographies and The Clearinghouse would like to make them available to others. If you know of someone working in this field, please let us know so we can provide them with our help.

Because an organization or resource is listed in this publication, it does not imply endorsement. If one is omitted, we apologize and would like to know about it. Several obvious sources such as The New York Times and other newpapers and major biolgical supply houses have been left out. These are easily available to any teacher.

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